

Cambridge International AS & A Level

# BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic  
+ Answer Scheme

**2015 - 2020**

**Complete Syllabus**



## Chapter 9

### Gas exchange and smoking



### 9.1 The gas exchange system

159. 9700\_m20\_qp\_22 Q: 4

- (a) When a section of lung tissue is viewed using a light microscope, it is possible to identify the trachea, the bronchus, the bronchioles and the alveoli.

Other than differences in their diameters, describe **one** structural difference visible between:

- the trachea and a bronchus

.....

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- a bronchus and a bronchiole

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.....

- a bronchiole and an alveolus.

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.....

[3]

- (b) The mitotic cell cycle of the stem cells present in the gas exchange system is carefully controlled. During interphase of the mitotic cell cycle, cells grow by increasing in size.

Complete Table 4.1 by:

- listing, in order, the three phases that occur during interphase
- stating **one** process, other than growth and respiration, that occurs in each of these three phases to help prepare the cell for mitosis.

Table 4.1

phase	process occurring during phase

[4]

[Total: 7]

160. 9700\_s20\_qp\_21 Q: 4

Fig. 4.1 shows the site of gas exchange in the mammalian lung.

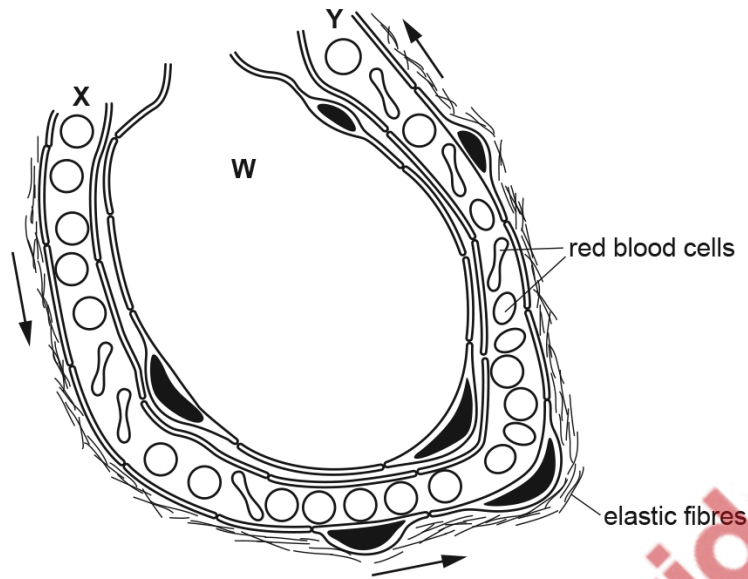


Fig. 4.1

(a) State **two** ways in which carbon dioxide is transported in the blood.

1 .....

2 .....

[2]

(b) Table 4.1 shows the partial pressures of oxygen ( $pO_2$ ) and carbon dioxide ( $pCO_2$ ) at locations **W**, **X** and **Y** in Fig. 4.1.

Table 4.1

partial pressure	locations within tissue		
	<b>W</b>	<b>X</b>	<b>Y</b>
$pO_2$ / kPa	13.87	5.33	13.87
$pCO_2$ / kPa	5.33	6.00	5.55

With reference to Fig. 4.1 and Table 4.1, describe the exchanges that occur as blood flows from X to Y.

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.....  
..... [4]

(c) Elastic fibres are present in tissues at the site of gas exchange in the lungs.

Describe the roles of elastic fibres in the gas exchange system and in the cardiovascular system.

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.....  
.....  
..... [4]

- (d) Scientists in Peru investigated the effect of moving from sea level to high altitude on the composition of blood. The scientists studied 10 students. Each student had lived at sea level since birth and then moved to live in the Andes at a height of 4500 metres above sea level.

The scientists took samples of blood from each student before they moved to live at high altitude. The scientists took further blood samples at intervals after the students had moved to high altitude.

The relative proportions of red blood cells and plasma in each sample were determined.

The total volume of blood for each student was also determined at each sampling time. As the students were all of different body mass, the total volumes were converted to a volume per kg of body mass ( $\text{cm}^3 \text{kg}^{-1}$ ).

Fig. 4.2 shows for each sampling time:

- the mean volume of blood per kg of body mass
- the proportions of red blood cells and plasma.

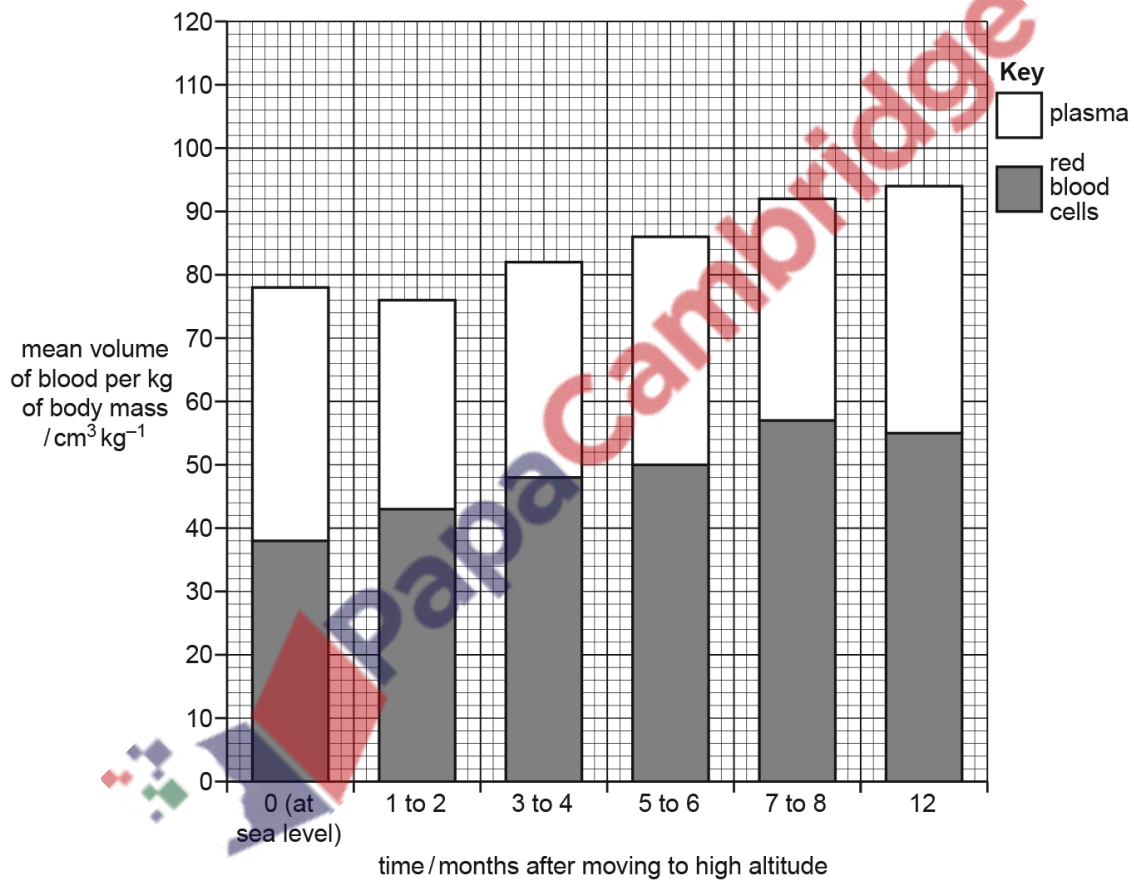


Fig. 4.2

- (i) The percentage of mean blood volume that is represented by red blood cells for the samples taken at sea level is 48%.

Calculate the percentage of mean blood volume that is represented by red blood cells at 5 to 6 months after living at high altitude.

Show your working and give your answer to the nearest whole number.

answer = .....% [2]

- (ii) Describe **and** explain the results in Fig. 4.2.

.....

.....

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.....

..... [4]

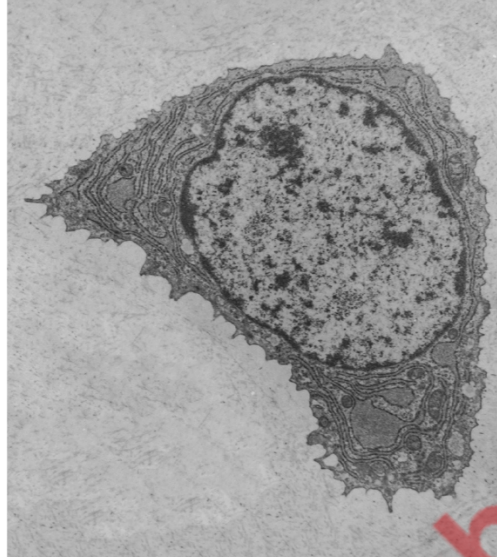
[Total: 16]



161. 9700\_s20\_qp\_22 Q: 4

Collagen is a major component of the cartilage found in some of the structures of the human gas exchange system. Cells that synthesise and secrete the components of cartilage are known as chondrocytes.

(a) Fig. 4.1 is a transmission electron micrograph of a chondrocyte.



**Fig. 4.1**

With reference to Fig. 4.1, explain **two** features of the chondrocyte that show how the cell is adapted to its function.

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.....

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..... [2]

(b) (i) Describe the distribution of cartilage in the human gas exchange system.

.....

.....

.....

..... [2]



- (ii) Outline the function of cartilage in the human gas exchange system.

.....  
 .....  
 .....  
 .....  
 ..... [2]

- (c) Fig. 4.2 shows part of the primary structure of a collagen polypeptide.

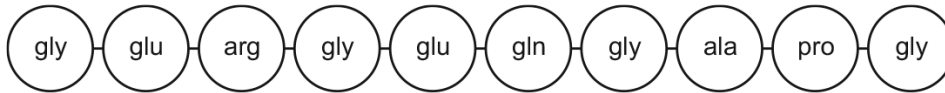


Fig. 4.2

- (i) Name the type of covalent bond formed between the amino acids shown in Fig. 4.2.

..... [1]

- (ii) Fig. 4.3 shows the molecular structure of the amino acid glycine (gly).

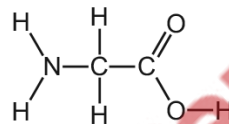


Fig. 4.3

With reference to Fig. 4.2 and Fig. 4.3 and the function of collagen, explain how the structure of a collagen polypeptide makes it suitable to form a collagen molecule.

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 .....  
 .....  
 .....  
 .....  
 .....  
 ..... [3]

[Total: 10]

162. 9700\_s20\_qp\_23 Q: 3

- (a) Fig. 3.1 is a photomicrograph of a section through two different types of blood vessels, X and Y.



**Fig. 3.1**

- (i) Name the two types of blood vessel shown by X and Y in Fig. 3.1.

X .....

Y .....

[1]



- (ii) State the reasons for your identification of the type of blood vessel shown by Y in Fig. 3.1.

.....

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.....

..... [2]

- (b) Tissue fluid and lymph are formed when blood arrives in the capillary networks of body tissues.

- (i) Explain why tissue fluid is more similar to blood plasma than it is to blood.

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.....

..... [2]

- (ii) Explain why the tissue fluid formed after blood arrives in the capillary network has a **higher** concentration of amino acids than the newly formed lymph draining away from the network.

.....

.....

..... [1]

- (c) The trachea, bronchi and bronchioles in the gas exchange system require a supply of glucose and oxygen from the blood for the functioning of smooth muscle.

Outline the function of smooth muscle in the gas exchange system.

.....

.....

.....

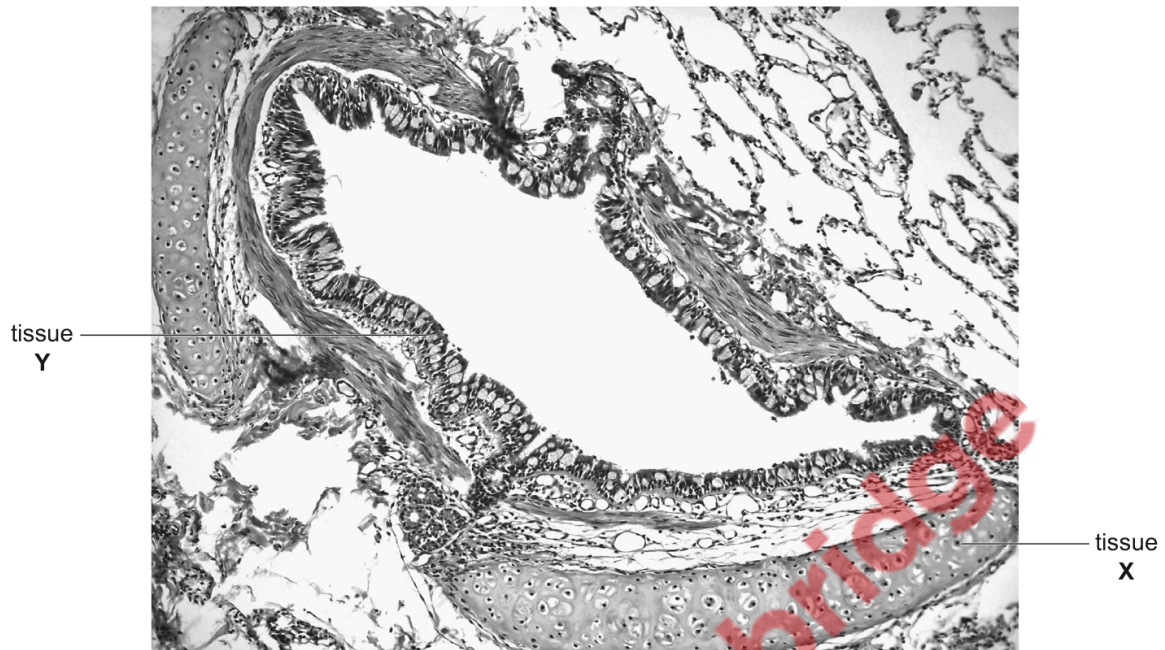
.....

..... [2]

[Total: 8]

163. 9700\_w20\_qp\_21 Q: 5

- (a) Fig. 5.1 is a photomicrograph of a section through the lungs showing a bronchus and some alveoli.



**Fig. 5.1**

- (i) State the function of tissue X labelled in Fig. 5.1.

.....  
..... [1]

- (ii) Describe how the distribution of tissue X in the trachea differs from that shown in Fig. 5.1.

.....  
..... [1]

- (iii) Describe how the epithelial tissue, Y, is adapted for its function.

.....  
.....  
..... [2]

(b) Fig. 5.2 is a photograph of two African elephants, *Loxodonta africana*.



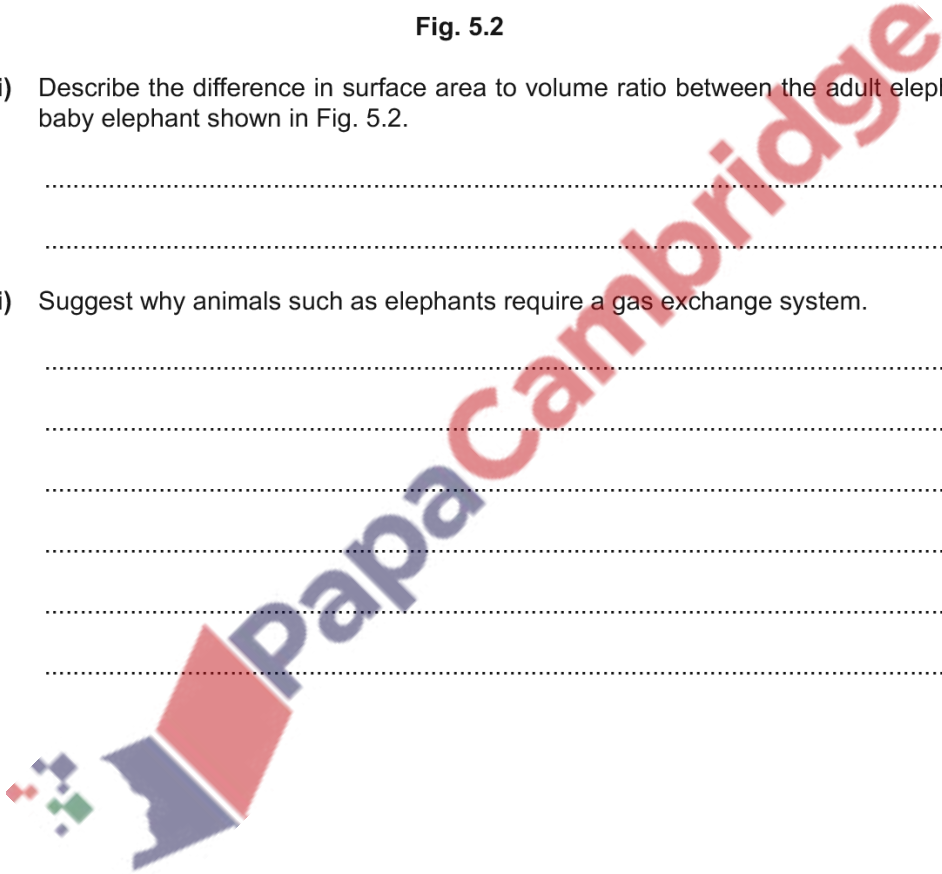
Fig. 5.2

(i) Describe the difference in surface area to volume ratio between the adult elephant and baby elephant shown in Fig. 5.2.

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..... [1]

(ii) Suggest why animals such as elephants require a gas exchange system.

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..... [3]





164. 9700\_w20\_qp\_22 Q: 3

Fig. 3.1 is a photomicrograph of a section through lung tissue.

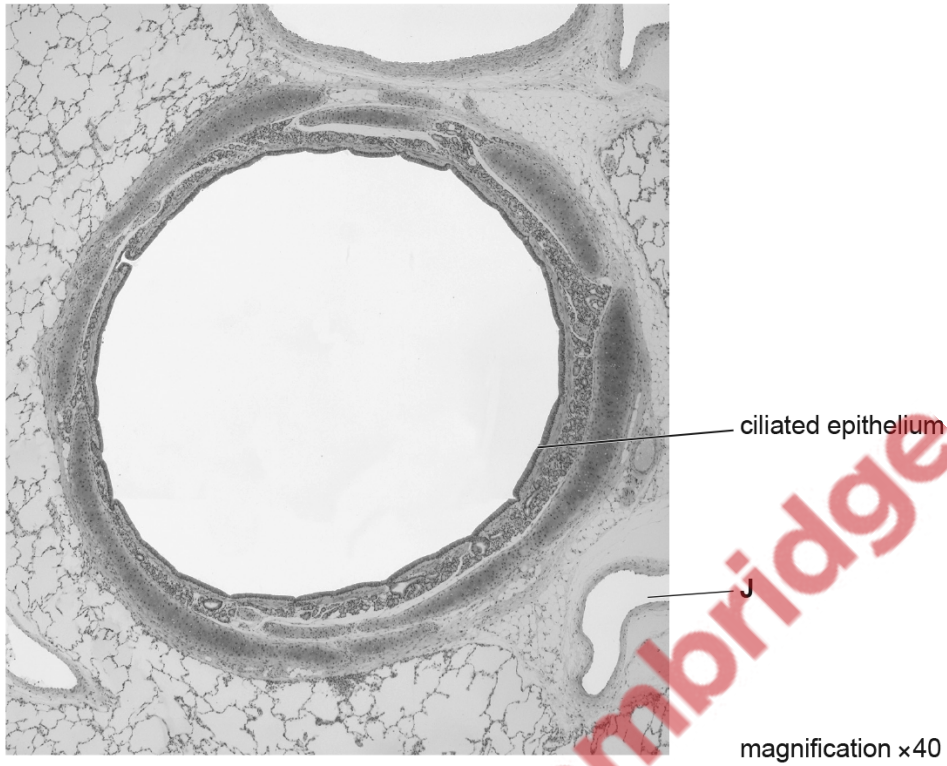


Fig. 3.1

- (a) State the feature visible in Fig. 3.1 that identifies the structure in the centre of the image as the bronchus **and** list other visible features that help to confirm this identification.

feature to identify the bronchus .....

.....  
.....

other features .....

.....  
.....  
.....  
.....  
.....  
.....

[3]

(b) Identify the structure labelled **J** in Fig. 3.1.

State the evidence visible in Fig. 3.1 that supports your answer.

.....  
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.....  
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.....  
.....

[2]

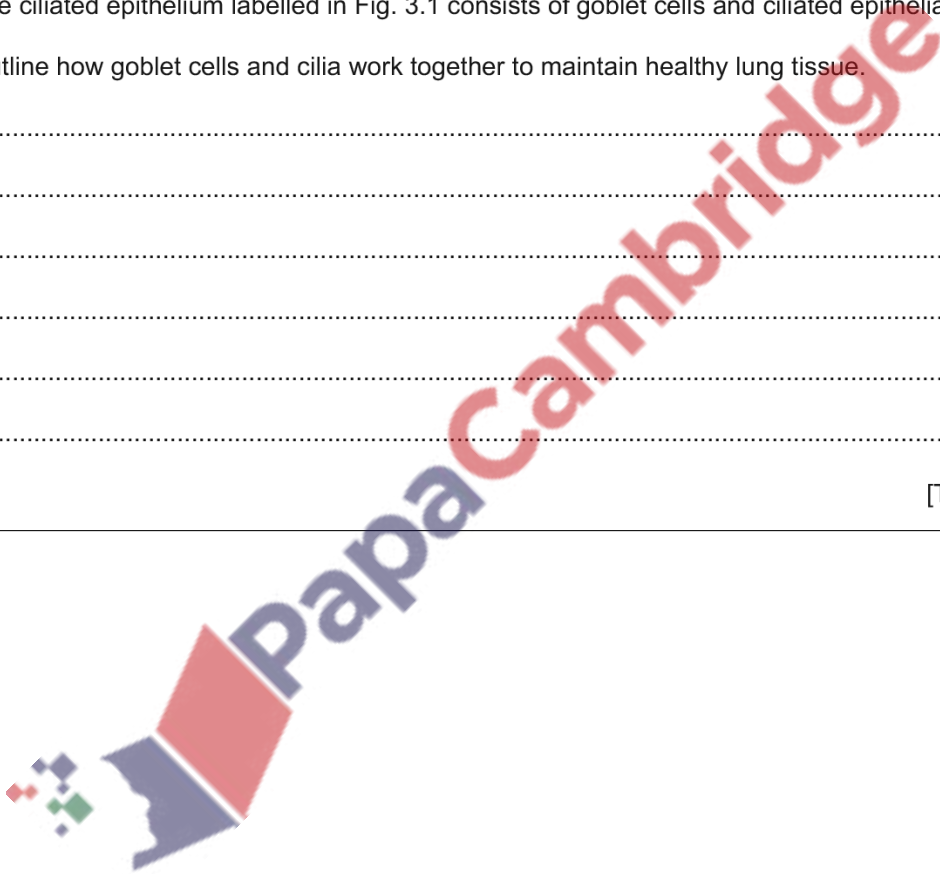
(c) The ciliated epithelium labelled in Fig. 3.1 consists of goblet cells and ciliated epithelial cells.

Outline how goblet cells and cilia work together to maintain healthy lung tissue.

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.....  
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[2]

[Total: 7]





165. 9700\_m19\_qp\_22 Q: 2

In mammalian red blood cells, carbonic anhydrase has an important role in the transport of carbon dioxide.

Carbonic anhydrase is an enzyme.

(a) Outline the features of an enzyme.

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..... [4]

(b) Complete Fig. 2.1 to show the reversible reaction involving carbonic anhydrase that takes place within red blood cells.

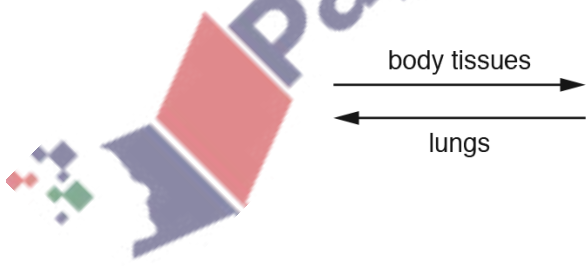


Fig. 2.1

[2]



166. 9700\_s19\_qp\_22 Q: 2

Some tissues of the gas exchange system include cells that are able to produce and secrete mucins. Mucins are stored in vesicles in these cells, ready for secretion. Once outside the cell, mucins adsorb water to form mucus.

- (a) Name the structures in the gas exchange system that produce and secrete mucins.

.....  
 ..... [2]

- (b) Mucins are described as glycosylated proteins. The process of glycosylation involves the addition of sugar components after polypeptides are synthesised.

Suggest **one** location in the cell where glycosylation of mucin could occur.

..... [1]

- (c) The processes that occur in the production and secretion of mucins are listed.

**translation                      exocytosis                      glycosylation                      transcription**

Complete Table 2.1 by writing the processes in the correct order in which they would take place.

**Table 2.1**

first process	
second process	
third process	
fourth process	

[2]

- (d) Chloride ions move out of the mucin-producing cells at the same time as mucin is secreted.  
Suggest **and** explain how the exit of chloride ions helps the formation of mucus from mucin.

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.....  
..... [3]

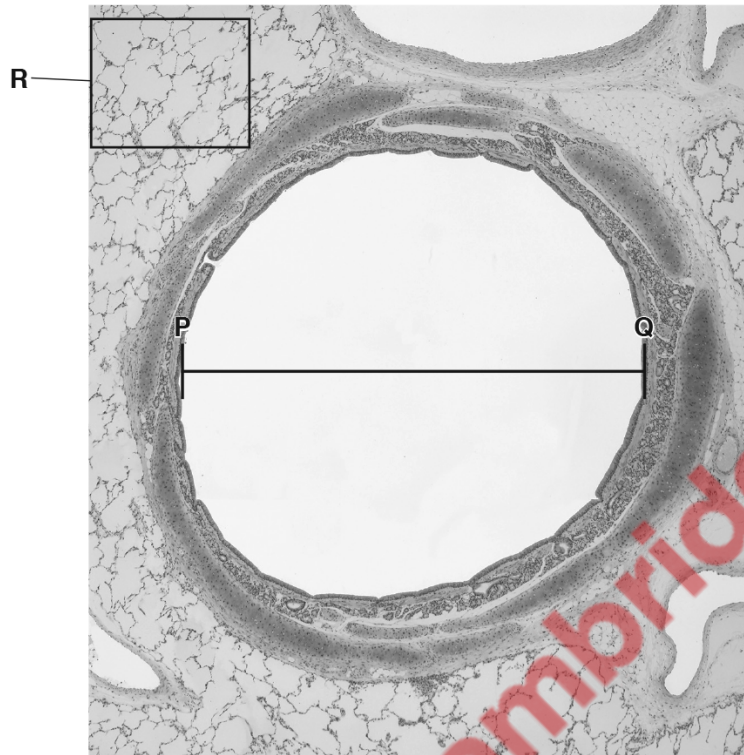
- (e) The gas exchange system includes some cells that are able to divide by mitosis.  
Explain why it is important to have these cells in the gas exchange system.

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.....  
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.....  
.....  
..... [3]

[Total: 11]

167. 9700\_s19\_qp\_23 Q: 2

Fig. 2.1 is a photomicrograph showing a transverse section through a bronchus and the surrounding lung tissue.



magnification x40

Fig. 2.1

- (a) Calculate the actual diameter of the lumen of the bronchus using the line P–Q.

Write down the formula used to make your calculation.

Show your working and give your answer to the nearest micrometre ( $\mu\text{m}$ ).

formula

actual diameter = .....  $\mu\text{m}$  [2]

(b) (i) In Fig. 2.1, the area labelled **R** shows a section through some alveoli.

Name the tissue that lines the air spaces of the alveoli.

..... [1]

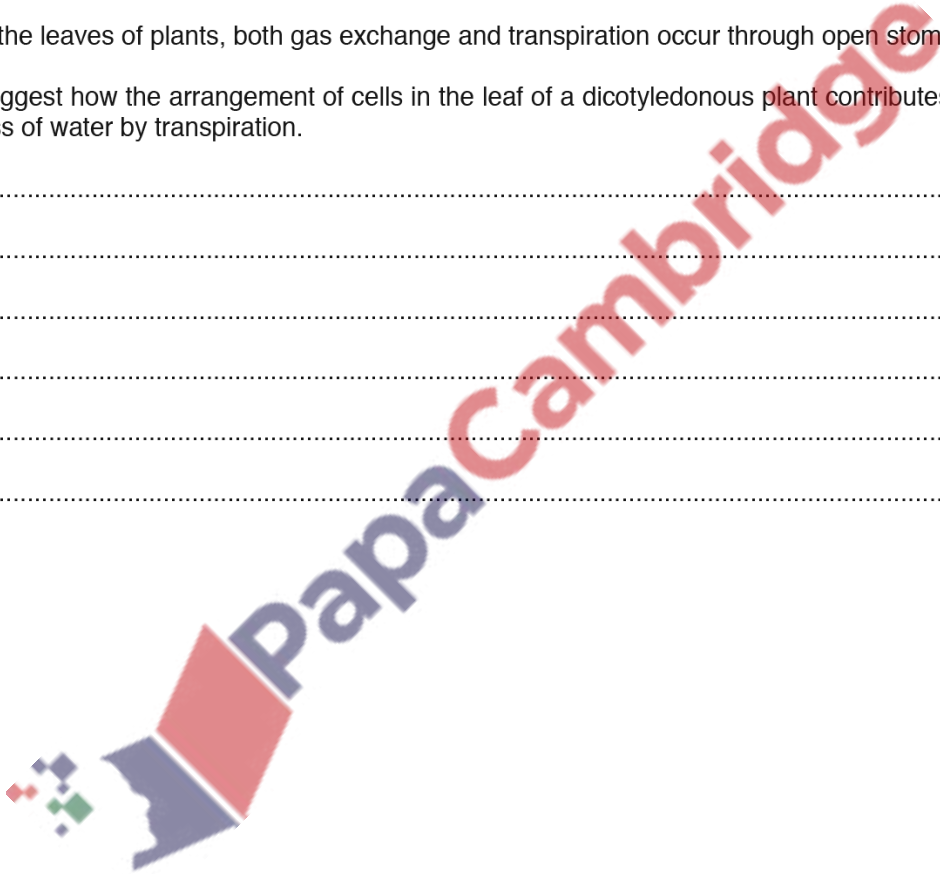
(ii) Suggest how the alveoli are adapted for gas exchange.

.....  
.....  
.....  
.....  
..... [2]

(c) In the leaves of plants, both gas exchange and transpiration occur through open stomata.

Suggest how the arrangement of cells in the leaf of a dicotyledonous plant contributes to the loss of water by transpiration.

.....  
.....  
.....  
.....  
.....  
..... [3]



(d) Fig. 2.2 shows the mean transpiration rate of a xerophyte between 08:00 and 19:00.

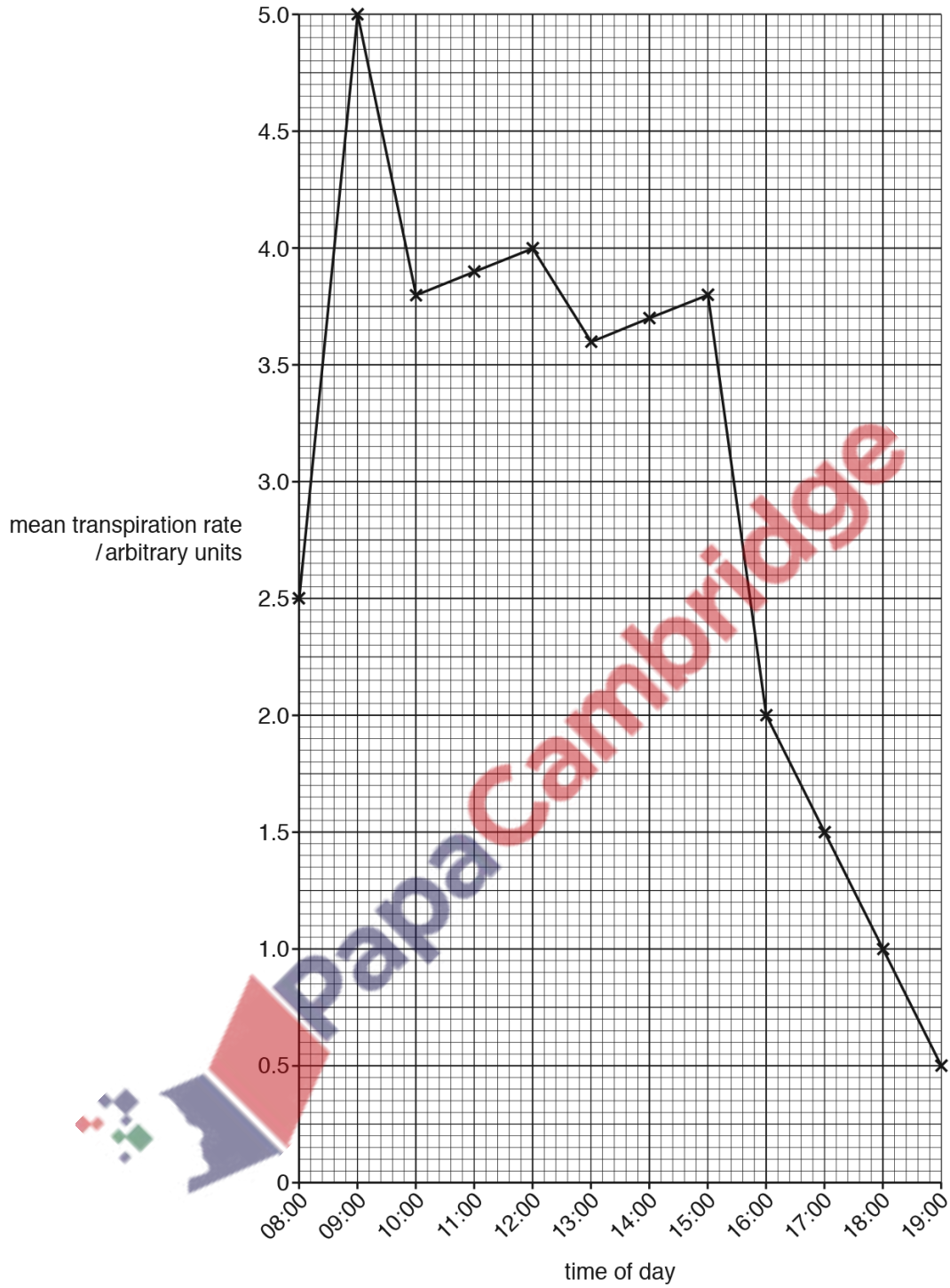


Fig. 2.2





168. 9700\_w18\_qp\_22 Q: 1

Fig. 1.1A is a photomicrograph of healthy lung tissue.

Fig. 1.1B is a photomicrograph of lung tissue from a person with emphysema, a chronic obstructive pulmonary disease (COPD). The images are both at magnification  $\times 40$ .

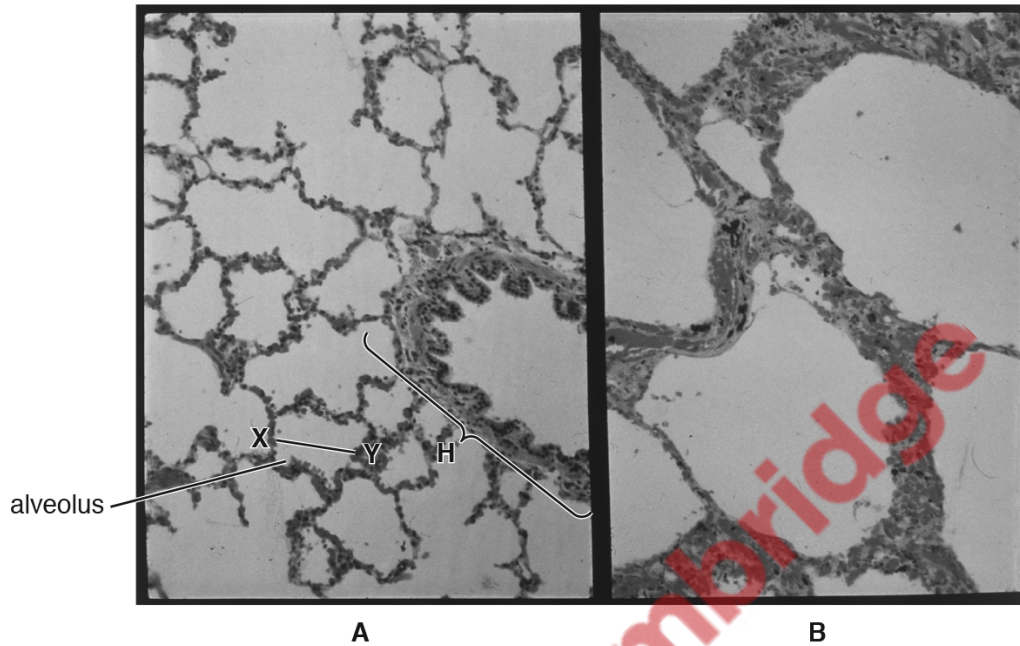


Fig. 1.1

(a) Name the structure labelled H in Fig. 1.1A.  
..... [1]

(b) Calculate the actual diameter of the alveolus at X–Y.  
Write down the formula and use it to make your calculation.  
Give your answer to the nearest whole micrometre ( $\mu\text{m}$ ).

formula

actual size .....  $\mu\text{m}$  [2]



169. 9700\_s16\_qp\_21 Q: 3

A student studied a transverse section of the trachea of a small mammal. The student drew a plan diagram of the section as shown in Fig. 3.1.

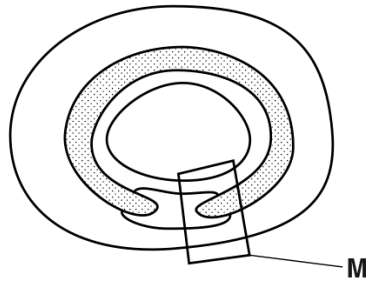


Fig. 3.1

Fig. 3.2 is a photomicrograph of the area labelled **M** in Fig. 3.1.



Fig. 3.2

(a) Name:

(i) the type of epithelium at **N**

.....[1]

(ii) the structures at **O**

.....[1]

(iii) the tissue at **P**.

.....[1]

(b) Smooth muscle in the trachea and in the bronchi relaxes during strenuous exercise.

Suggest the advantages of relaxing this smooth muscle during periods of strenuous exercise.

.....  
.....  
.....  
.....  
.....  
.....[2]

(c) The walls of the trachea and bronchi contain elastic fibres.

Elastic fibres are made of bundles of the fibrous protein elastin.

- Each molecule of elastin is a single polypeptide.
- The primary structure contains a large proportion of the amino acid glycine.
- Glycine has a hydrophobic R group.
- Glycine does not occur at regular intervals in the polypeptide.
- The polypeptide forms random coils that change shape as the elastic fibres are stretched and recoil.
- Elastin molecules are joined to each other by many covalent bonds to form a cross-linked network.

Describe two ways in which the structure of a collagen molecule **differs** from the structure of an elastin molecule described above.

1 .....

.....

2 .....

.....[2]

[Total: 7]



170. 9700\_s16\_qp\_22 Q: 4

Fig. 4.1 is a simplified diagram of the circulatory system of a mammal. Some of the lymph system is also shown.

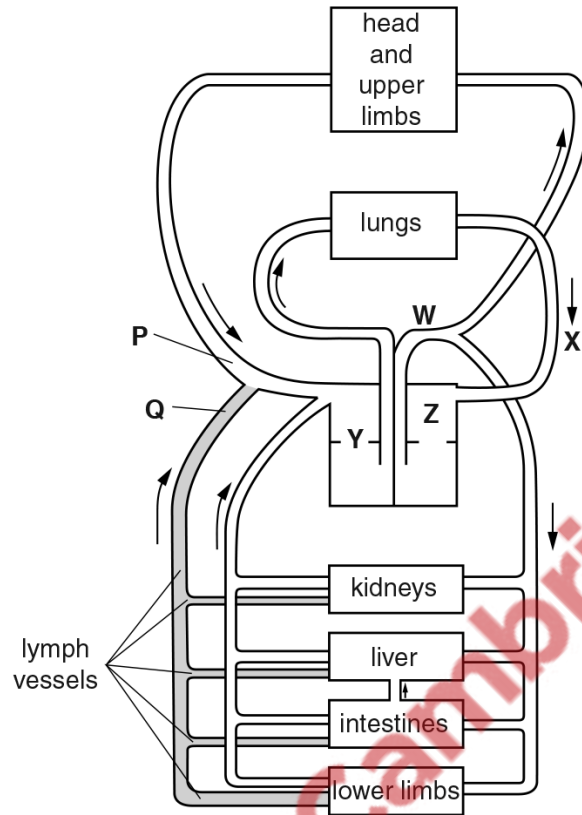


Fig. 4.1







171. 9700\_w15\_qp\_22 Q: 1

A student compared an image of a plant cell with an image of an animal cell. Both images were at the same magnification.

Parts (a) to (c) are four correct comparative statements about these images.

(a) Both cells contain large numbers of an organelle, bound by a double membrane. The inner membrane of these organelles is folded. These organelles all have a similar structure but do not always appear to have the same shape.

(i) State the name of the organelles described.

..... [1]

(ii) Suggest **one** reason why the organelles described do not always seem to have the same shape.

.....  
.....  
..... [1]

(b) Both cells contain cell structures that are approximately 25 nm in diameter and are **not** bound by a membrane.

(i) State the name of the cell structures described.

..... [1]

(ii) Draw a circle around the measurement that has the same value as 25 nm.

**0.00025 μm**      **0.0025 μm**      **0.025 μm**      **0.25 μm**      **2.5 μm**

[1]

(c) There are strands of cytoplasm passing through channels in the cell wall of the plant cell. These are not visible in the animal cell.

(i) State the name of the cell structures described.

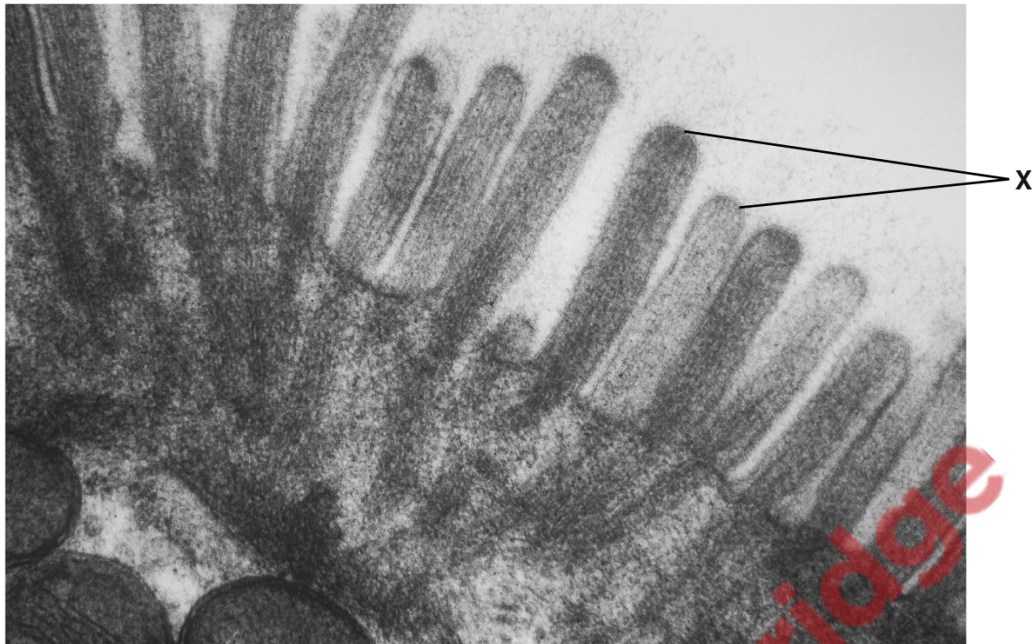
..... [1]

(ii) Explain **one** advantage to the plant cell of having these structures.

.....  
.....  
.....  
..... [1]



- (d) Fig. 1.1 is a transmission electron micrograph of part of an epithelial cell from the small intestine of a mammal.



magnification  $\times 65000$

**Fig. 1.1**

Name the cell structures labelled **X** in Fig. 1.1 and state their function.

.....  
.....  
.....  
..... [1]

[Total: 7]



## 9.2 Smoking

172. 9700\_w20\_qp\_23 Q: 1

Fig. 1.1 shows a section through the human chest. The gross structure of the human gas exchange system is shown.

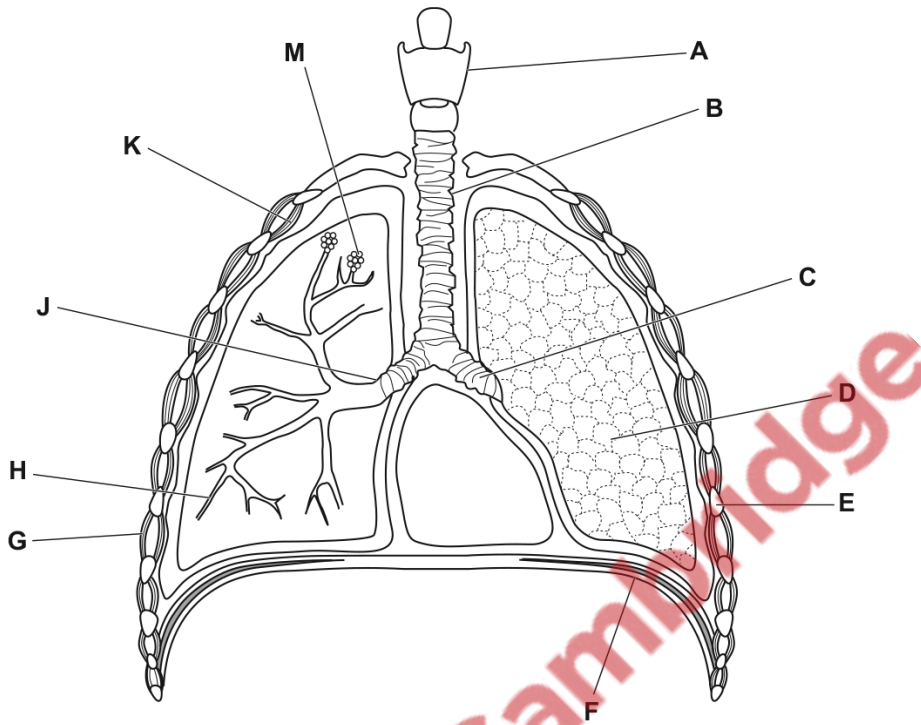


Fig. 1.1

(a) Descriptions of some parts of the gas exchange system are shown in Table 1.1.

Complete Table 1.1 to:

- state the name of the part described
- write a letter from Fig. 1.1 to identify each part.

Table 1.1

description	name of part of gas exchange system	letter from Fig. 1.1
supported by incomplete (C-shaped) rings of cartilage		
lined by ciliated epithelium and supported by blocks of cartilage		
lined by squamous epithelium		
lined by ciliated epithelium, but not supported by cartilage		

[4]

- (b) Tobacco smoke contains a number of compounds which can affect the body.

State the appropriate term that matches each of the statements **A** to **E**.

- A** The type of chemical that causes mutation of genes that control the cell cycle.

.....

- B** A component that causes a short-term increase in blood pressure.

.....

- C** A component that reduces the carrying capacity of haemoglobin for oxygen.

.....

- D** A component that increases the production and secretion of mucus from goblet cells.

.....

- E** A component that causes a short-term increase in heart rate.

.....

[5]

[Total: 9]

---



- (b) The alveolus is the gas exchange surface in mammals. For efficient oxygen uptake, a steep diffusion gradient is maintained between the alveolar air and the blood.

Suggest how the steep diffusion gradient for oxygen is maintained at the gas exchange surface.

.....  
.....  
.....  
.....  
..... [2]

- (c) Compared to when they were non-smokers, the ability of people who smoke tobacco to deliver oxygen to their body tissues is reduced. Two causes of this reduction include:

- a decrease in the volume of air per breath moving towards the alveoli
- a decrease in the ability of red blood cells to carry oxygen.

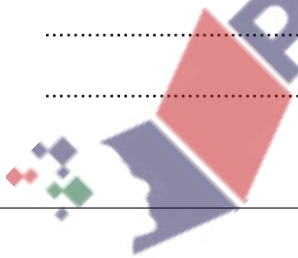
- (i) Suggest **one** reason why smoking tobacco, even after only a short time, may cause a decrease in the volume of air per breath moving towards the alveoli.

.....  
..... [1]

- (ii) Explain why smoking tobacco causes a decrease in the ability of red blood cells to carry oxygen.

.....  
.....  
.....  
.....  
..... [2]

[Total: 8]



174. 9700\_w19\_qp\_21 Q: 6

(a) Outline the role of DNA polymerase in the replication of DNA.

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.....  
.....  
.....  
..... [3]

(b) Floxuridine is a drug used to treat cancer.

(i) Floxuridine inhibits DNA replication.

Suggest why the inhibition of DNA replication is an effective treatment for cancer.

.....  
.....  
..... [1]

(ii) Floxuridine prevents thymine nucleotides being produced.

Explain why floxuridine does **not** affect transcription.

.....  
.....  
..... [1]

(c) Fig. 6.1 is a scanning electron micrograph of a lung cancer cell in a stage of the cell cycle.

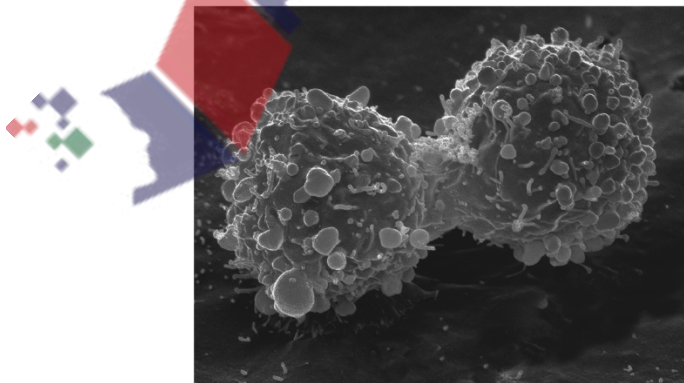


Fig. 6.1

(i) Name the stage of the cell cycle occurring in Fig. 6.1.

..... [1]

(ii) Explain why smoking tobacco increases the risk of developing lung cancer.

.....

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.....

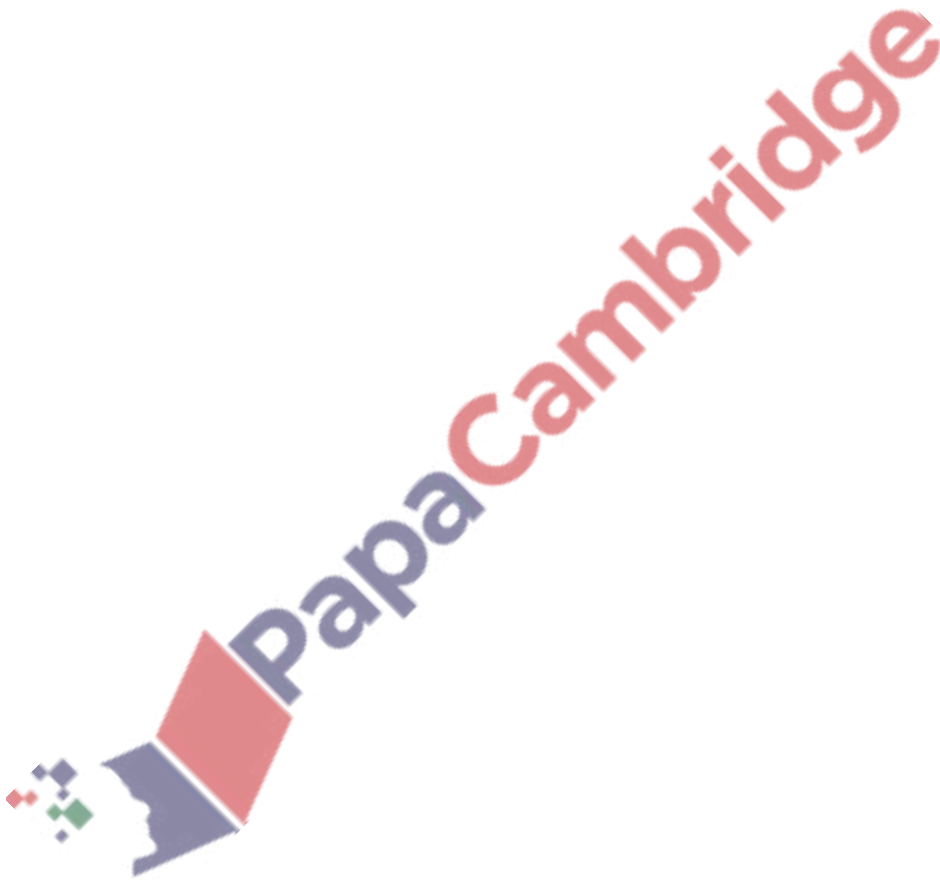
.....

.....

..... [3]

[Total: 9]

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175. 9700\_w19\_qp\_22 Q: 2

People who smoke tobacco are at an increased risk of developing non-infectious diseases of the gas exchange system and the cardiovascular system.

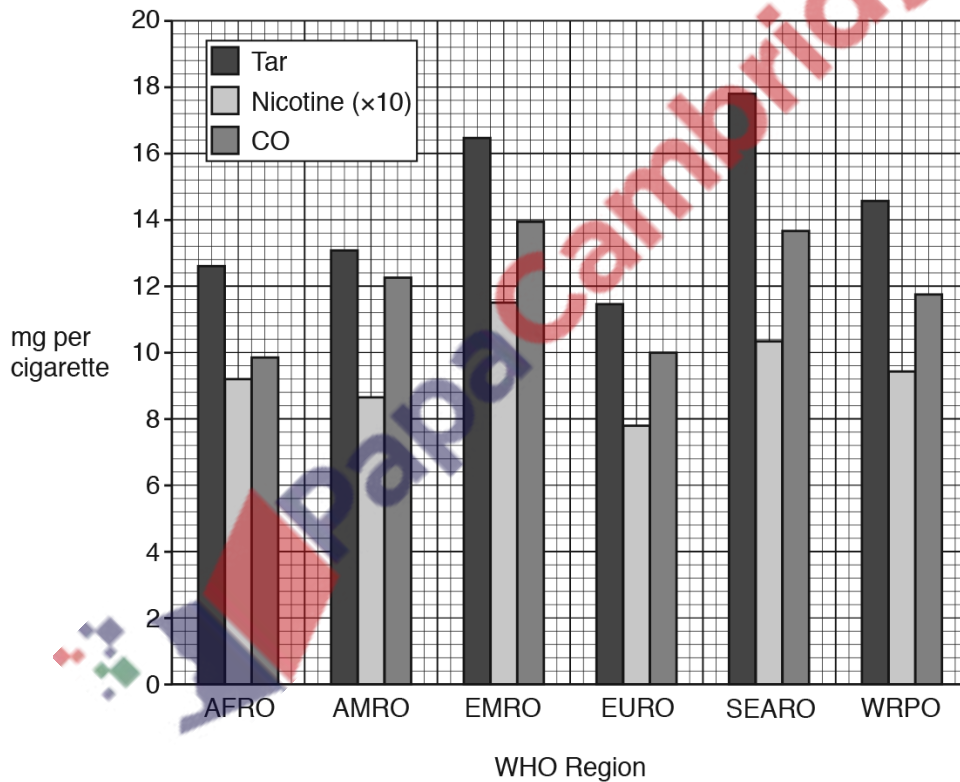
In 2004, a study was carried out on the most popular brands of filter cigarettes from each of the six World Health Organization (WHO) regions.

In this study, the smoke passing through the filter was analysed for the tar, nicotine and carbon monoxide (CO) content for each brand of cigarette. For each WHO region, the mean content of tar, nicotine and carbon monoxide of the different brands of cigarette was calculated.

The results are shown in Fig. 2.1.

**Key to WHO regions**

- AFRO = African Region
- AMRO = Region of the Americas
- EMRO = Eastern Mediterranean Region
- EURO = European Region
- SEARO = South-East Asia Region
- WRPO = Western Pacific Region



**Fig. 2.1**



- (a) With reference to Fig. 2.1, list the **two** WHO regions where smokers are at the highest risk of developing diseases of the gas exchange or cardiovascular systems.

.....  
.....  
..... [1]

- (b) With reference to Fig. 2.1, explain why smoking a popular brand of cigarette from the AFRO region is more likely to increase the risk of blood clots forming than smoking a popular brand of cigarette from the EURO region.

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..... [2]

- (c) One short-term effect of cigarette smoking is a decrease in the supply of oxygen to body tissues.

Describe **and** explain why cigarette smoking leads to a decrease in the supply of oxygen to body tissues.

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..... [4]

[Total: 7]

176. 9700\_m17\_qp\_22 Q: 5

- (a) Smooth muscle and cartilage are two of the tissues found in the walls of structures of the gas exchange system of mammals.

Complete Fig. 5.1 to show the distribution of these tissues in the gas exchange system of mammals.

Choose from the four structures listed below.

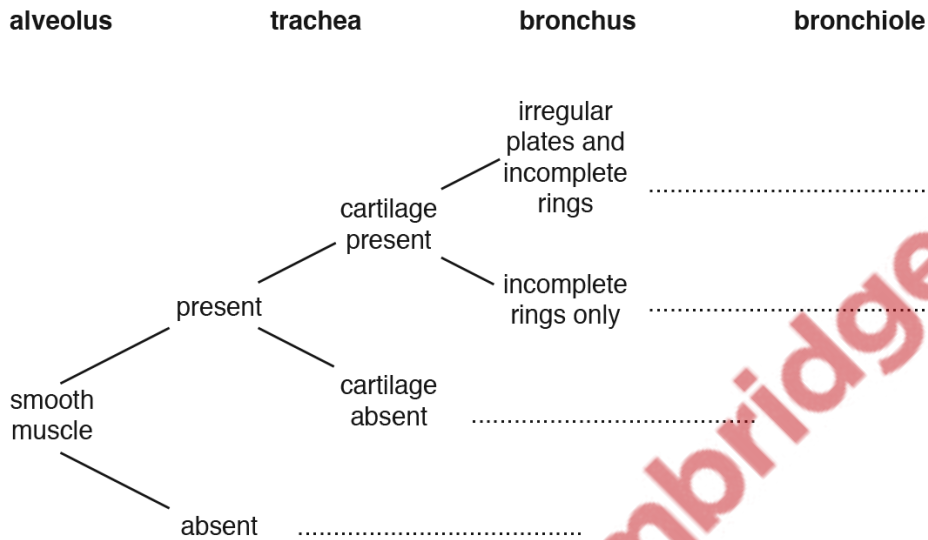


Fig. 5.1

[3]

Tobacco smoke is known to be one of the causes of lung cancer and chronic obstructive pulmonary disease (COPD).

- (b) Outline how tobacco smoke may cause lung cancer.

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.....

.....

.....

.....

.....

..... [2]



177. 9700\_s17\_qp\_22 Q: 5

Some pathogens can enter the human body through the gas exchange system.

(a) The epithelial lining of the gas exchange system is adapted for defence against pathogens.

(i) List the structures in the gas exchange system that have a ciliated epithelial lining.

.....  
.....[1]

(ii) Name the cells in the ciliated epithelium that synthesise and secrete mucus.

.....[1]

Alveolar macrophages are cells of the immune system. They have an important role in defence against respiratory infections.

(b) The infectious lung disease, pneumonia, can be caused by *Streptococcus pneumoniae*.

Most healthy people inhaling air containing these bacteria do **not** become ill because of the action of the alveolar macrophages.

Outline the mode of action of an alveolar macrophage in response to the presence of *S. pneumoniae*.

You may use diagrams with notes to help your answer.

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.....[3]

Irritants in tobacco smoke can contribute to emphysema, one of the chronic obstructive pulmonary disorders (COPD). In emphysema, the alveoli lose their ability to recoil on expiration and can burst.

- (c) Suggest how the structure of the alveolar wall changes so that an alveolus bursts.

.....  
.....  
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.....  
.....[2]

- (d) Some alveolar cells produce a surfactant that helps to prevent the collapse of alveoli on exhalation. Too much surfactant decreases the efficiency of gas exchange in the alveoli.

A glycoprotein known as GM-CSF is released by some cells of the immune system when there is too much surfactant in the alveoli. Excess surfactant is then broken down by alveolar macrophages.

Receptors for GM-CSF are on the cell surface membranes of alveolar macrophages.

Explain how maintaining the correct quantity of surfactant in the alveoli is the result of a cell signalling mechanism.

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.....[4]

[Total: 11]

178. 9700\_s17\_qp\_23 Q: 1

Mammals have a closed double circulation system.

(a) Explain what is meant by a *closed double circulation*.

.....  
.....  
.....  
.....  
.....[2]

(b) Table 1.1 shows some structures in the mammalian circulatory system.

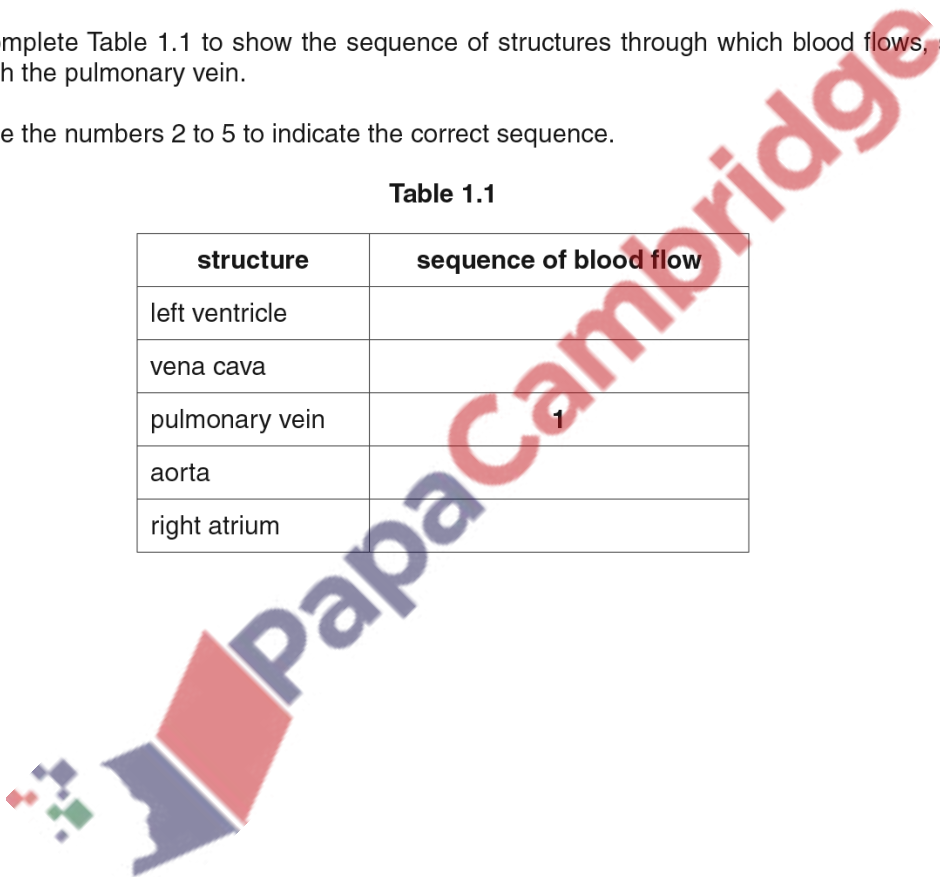
Complete Table 1.1 to show the sequence of structures through which blood flows, starting with the pulmonary vein.

Use the numbers 2 to 5 to indicate the correct sequence.

**Table 1.1**

structure	sequence of blood flow
left ventricle	
vena cava	
pulmonary vein	1
aorta	
right atrium	

[2]



- (c) (i) Explain why arteries have thicker walls than veins.

.....  
.....  
.....  
.....  
.....[2]

- (ii) Smoking causes carbon monoxide and nicotine to enter the blood.

Describe the short-term effects of each of these substances on the cardiovascular system.

*carbon monoxide*

.....  
.....  
.....

*nicotine*

.....  
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.....[4]

[Total: 10]



179. 9700\_M16\_qp\_22 Q: 6

- (a) Fig. 6.1 shows the first three structures of the human gas exchange system through which air from the external atmosphere passes during inhalation.

Complete Fig. 6.1 to show the pathway that air takes during inhalation.

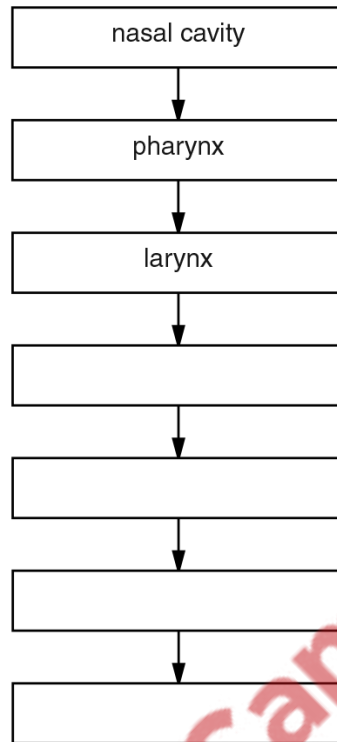


Fig. 6.1

[2]

- (b) The inhalation of tobacco smoke can lead to chronic obstructive pulmonary disease (COPD). COPD is a term used to describe a collection of lung diseases.

Name two smoking-related diseases associated with COPD.

1 .....

2 .....[2]

[Total: 4]



180. 9700\_s16\_qp\_23 Q: 1

Fig. 1.1 is a photomicrograph of epithelial cells in the bronchus.

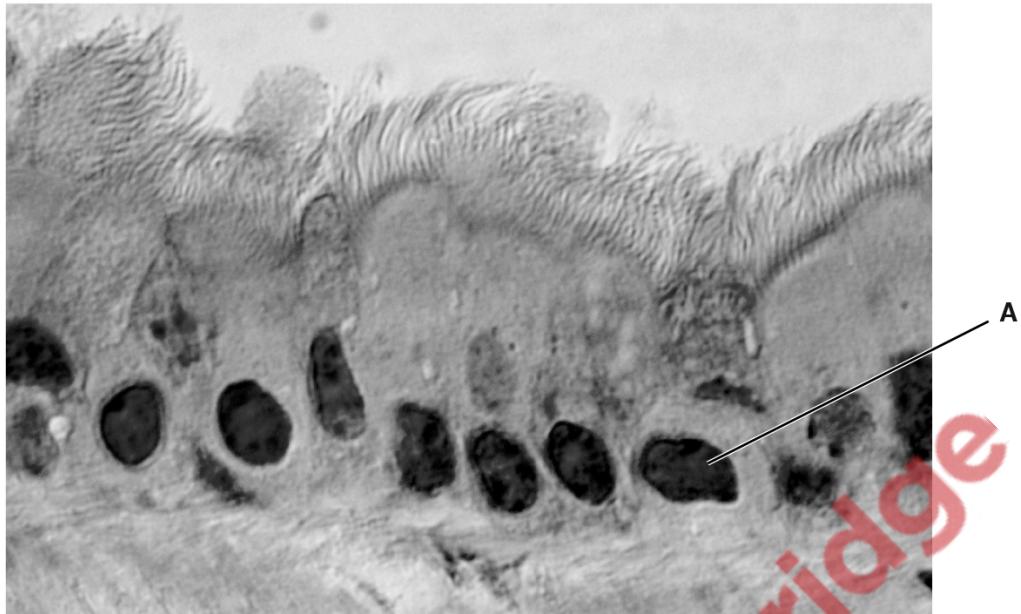


Fig. 1.1

- (a) (i) Write a letter **X** on Fig. 1.1 to show the lumen of the bronchus. [1]
- (ii) Name the structure in Fig. 1.1 labelled **A**.  
 .....[1]
- (iii) State **one** feature of the cells, **visible in Fig. 1.1**, which indicates that these are **not** epithelial cells from the alveolus.  
 .....[1]



(b) Epithelial cells are replaced when they are damaged.

(i) Name the type of cell division used to replace damaged epithelial cells.

.....[1]

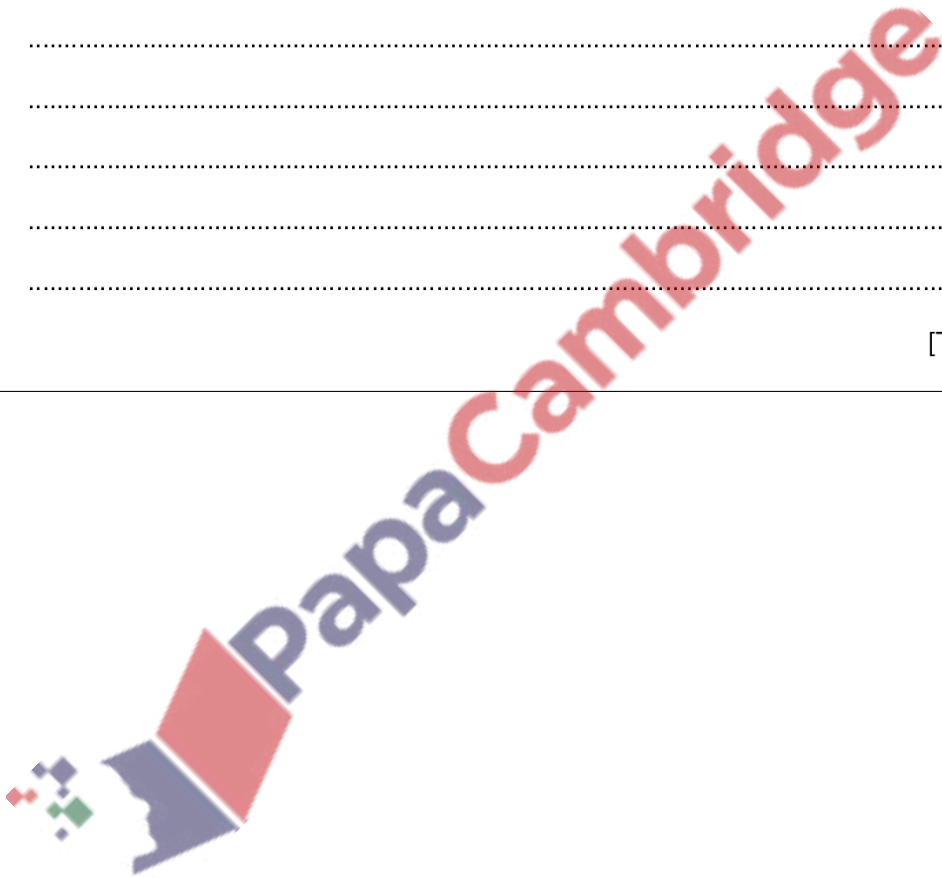
(ii) The cells shown in Fig. 1.1 are from a non-smoker.

Smoking causes damage to the epithelial cells of the lungs.

Describe the appearance of the lining of the bronchus in a long-term smoker.

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.....[3]

[Total: 7]





(d) Explain why red blood cells are in blood but not in tissue fluid.

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.....  
.....[1]

[Total: 11]

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182. 9700\_w15\_qp\_23 Q: 5

Nicotine and carbon monoxide in tobacco smoke contribute to damage to the cardiovascular system.

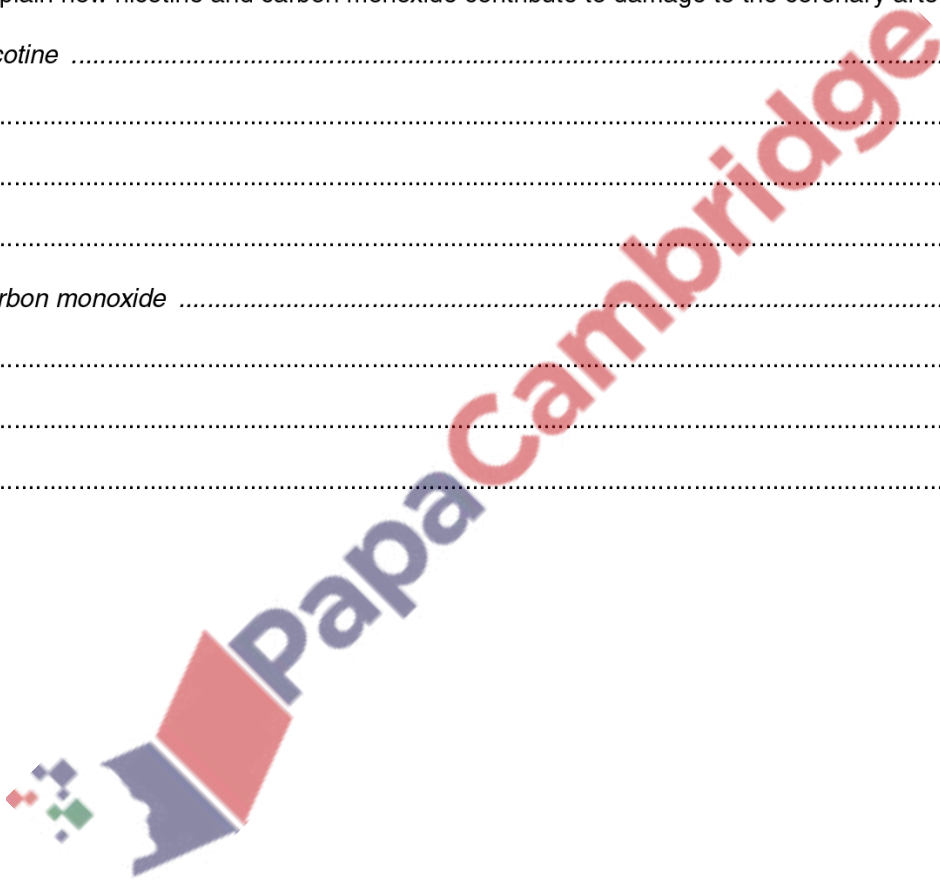
(a) Explain how nicotine and carbon monoxide contribute to damage to the coronary arteries.

*nicotine* .....

.....  
.....  
.....

*carbon monoxide* .....

.....  
.....  
..... [3]



- (b) One type of surgical treatment for coronary heart disease is to use arteries from the chest and veins from the leg to by-pass blockages as shown in Fig. 5.1.

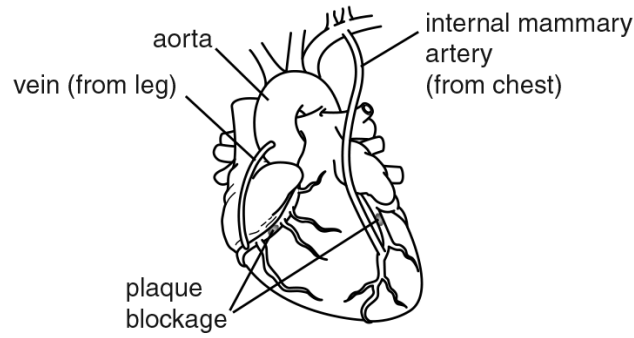


Fig. 5.1

- (i) Explain how the two by-passes shown in Fig. 5.1 provide an effective treatment for coronary heart disease.

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..... [3]

- (ii) The cost of treating heart disease is very high.  
Suggest the steps that governments could take to reduce heart disease in the population.

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..... [3]

[Total: 9]